

**THE ARCTIC OCEAN: A KEY TO UNDERSTANDING THE DYNAMICS OF THE EUROPEAN ENVIRONMENT AND A DRIVER OF GLOBAL CHANGE**

## **THE AURORA BOREALIS PROJECT**

**SCIENCE PLAN 2006-16**

**DRAFT ONLY** (March 2003)



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## Executive Summary

Polar research and in particular the properties of northern and southern high latitude oceans are currently a subject of intense scientific debate and investigations, because they are (in real time) and have been (over historic and geologic time scales) subject to rapid and dramatic change. Polar Regions react more rapidly and intensively to global changes than other regions of the earth. News about shrinking of the Arctic sea-ice cover, potentially leading to an opening of sea passages to the north of North America and Eurasia, on the long to a “blue” Arctic Ocean, as well as about the calving of giant table icebergs from the ice shelves of Antarctica are examples for these modern dynamics.

Until now it is not clear, whether the profound change in all parts of the Arctic is a natural fluctuation or is due to human activity. Since this change is a phenomenon of decades, long time data series of atmospheric and oceanic conditions are needed for its understanding and prediction of its further development. Despite the strong seasonality of polar environmental conditions, research in the central Arctic Ocean up to now could essentially only be conducted during the summer months, when the Arctic Ocean is accessible to the currently available research icebreakers.

European nations have a particular interest in understanding the Arctic environment with its potential for change because highly industrialized countries reach into high northern latitudes and Europe is under the steady influence of and in exchange with the Arctic environment. In addition considerable living and non-living resources are found in the Arctic Ocean, its deep-sea basins and their adjacent continental margins. Modern research vessels capable of penetrating into the central Arctic are few. A new state-of-the-art research icebreaker is therefore urgently required to fulfil the needs of European polar research and to document multi-national European presence in the Arctic. This new icebreaker would be conceived as an optimized science platform from the keel up and will allow conducting long, international and interdisciplinary expeditions into the central Arctic Ocean during all seasons of the year.

Global climate models demonstrate the sensitivity of the polar areas to changes in forcing of the ocean/climate system. The presence or absence of snow and ice influences global heat distribution through its effect on the albedo, and the polar oceans are the source of dense, cold bottom waters, which influence thermohaline circulation in the world oceans. This global conveyor is a major determinant of global climate.

In spite of the critical role of the Arctic Ocean in climate evolution, it is the only sub-basin of the world's oceans that has not been sampled by the drill ships of the Deep-Sea Drilling Project (DSDP) or the Ocean Drilling Program (ODP) and its long-term environmental history and tectonic structure is therefore poorly known. This lack of data represents one of the largest gaps of information in modern Earth Science, also relevant for the field of hydrocarbon exploration. Therefore, the new research icebreaker AURORA BOREALIS (Fig.1) should be

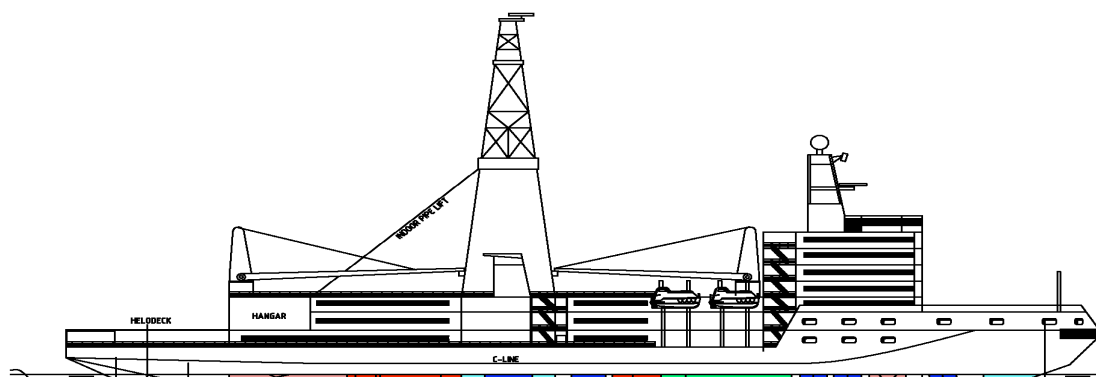
equipped with drilling facilities to fulfil the needs of the IODP (Integrated Ocean Drilling Program, starting in 2003) for an “Alternate Platform” to drill in deep, permanently ice-covered ocean basins. The drilling equipment will only be used during the summer months and should be removable, potentially to be used and adopted to ICDP-projects. The icebreaker must also be powerful enough to keep station against the drifting sea-ice cover and will have to be equipped with dynamic positioning.

AURORA BOREALIS will be a novel research icebreaker with no national or international competitor because of its drilling capability, its sophisticated modularized mobile laboratory systems allowing mission-specific laboratory selections, its moon pools for drilling and for the deployment of Remotely Operated Vehicles (ROV) and Autonomous Underwater Vehicles (AUV) for sub-ice surveys, its propulsion and dynamic positioning systems and its capability for polar expeditions into high latitude ice-covered deep-sea basins also during the unfavourable seasons of the year.

An efficient use of the new research icebreaker requires the formation of a consortium of European countries and their polar research institutions to ensure a high quality of science and efficient employment of the research vessel during all seasons of the year. Extensive and well-developed Arctic research programmes exist in several European countries, particularly in the Scandinavian countries, Russia, and Germany. In each individual country, there exist different organizations or working groups, with rather diverse structures and impacts in their home countries. The construction of AURORA BOREALIS as a joint European research icebreaker would result in a considerable commitment of the participating nations to co-ordinate and expand their polar research programmes in order to operate this expensive ship continuously and with the necessary efficiency. If AURORA BOREALIS is eventually established as a European research icebreaker for the Arctic, European polar research will be strengthened; Europe will contribute to meet the Arctic drilling challenge within IODP and retain its top position in Arctic research.

However, in a long-term perspective the AURORA BOREALIS could also be used to address Antarctic research targets, both in its mode as a regular research vessel as well as a polar drill ship.

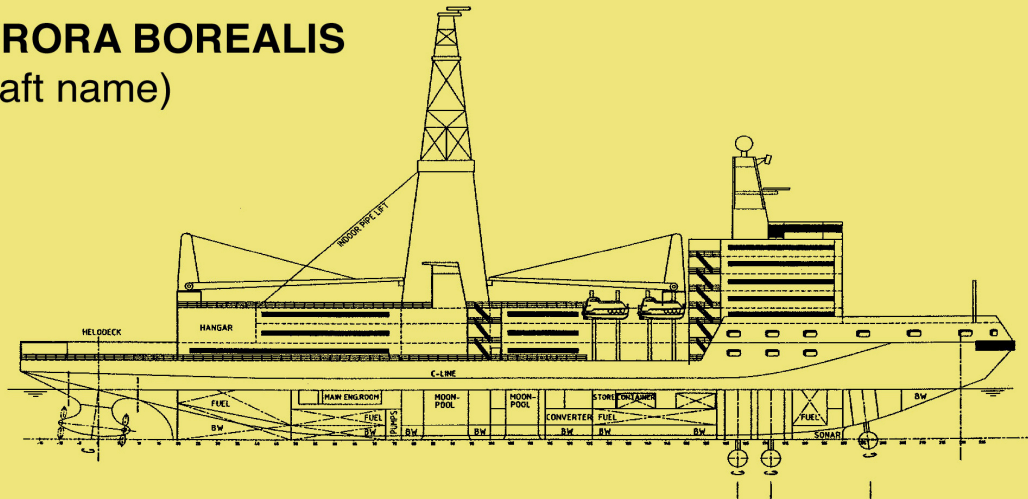
Ideas for a new research icebreaker for the Arctic have been developed by several groups. The sketch below demonstrates the initial design of The Aurora Borealis:



(Dr. K.H. Rupp)

## PROPOSAL FOR A NEW DEDICATED EUROPEAN ARCTIC RESEARCH ICE BREAKER (WITH A DEEP OCEAN DRILLING CAPABILITY)

### AURORA BOREALIS (Draft name)



Designed by HSVA

### Scientific and Economic Objectives

- ▶ The high latitude oceans are subject to rapid changes with vital environmental consequences and also with economical opportunities. The latest example is provided by the news about the shrinking of the Arctic sea ice cover, which could lead potentially to an opening for the sea traffic through the sea routes to the north of North America and Eurasia.
- ▶ The central Arctic Ocean has not been visited by a deep-drilling research vessel (DSDP/ODP) and therefore its long-term environmental history as well as the tectonic structure are poorly known. A European contribution to IODP is urgently needed.
- ▶ A new dedicated European research ice breaker with a deep ocean drilling capability would provide the opportunity to conduct international, interdisciplinary expeditions during all seasons of the year and to penetrate into permanently ice-covered basins of the central Arctic Ocean.

### Dimensions (draft design) and Capabilities of the new ice breaker

- ▶ Length LPP 132.00 m; displacement 23,000 t.
- ▶ Ability to serve the needs of the polar science disciplines: meteorology, glaciology, oceanography, biology, geology and

geophysics as well as marine technology. Capacity of laboratories and electronic areas is 2300 m<sup>2</sup>.

- ▶ Ability to endure winter and spring expeditions to the permanently ice-covered central Arctic Ocean. Ice breaking performance of more than 2 m and dynamic positioning in ice.
- ▶ Deep drilling and coring capability in up to 4 km water depths penetrating into the sea floor up to 1 km.

### The European Aspect

- ▶ Promotion of the continuity for European polar research programmes and of the internationally successful competition about the leadership in Arctic research.
- ▶ The new research ice breaker is thought of as an alternate platform in the European contribution to the successor of the Ocean Drilling Program, the Integrated Ocean Drilling Program (IODP).
- ▶ The formation of a European Consortium of interested institutes/countries is required to share the responsibility for the planning and construction of the Arctic ice breaker and to coordinate the scientific programmes.

Fig. 1: The Project AURORA BOREALIS.

## A Vision of European Collaboration in Polar Arctic Sciences

***...The critical role of the Arctic in regulating and driving the Global Climate System is one that requires elucidation in all its complexities. This is to predict future environmental changes and determine strategies that must be adopted by Nations to protect the functioning of the Earth System...***

European Nations have a particular interest in understanding the Arctic Environment with its inherent sensitivity to change. The Arctic Ocean contains considerable living and non-living resources. The interactions and effects of human influence must be understood in order to develop adequate means of protection and potential scientific and economic use of this unique environment. The development of a unique European Research platform icebreaker will enable the study of physical, chemical and biological processes in the Arctic regions during all seasons of the year and will promote internationally integrated and multidisciplinary science programmes based on a unique large research facility. The AURORA BOREALIS Project is a core element of a European strategic Framework in Polar Sciences EUROPOLAR and is a concept, which enables strengthening, expansion and commitment to the organisation and implementation of European Arctic research.

Global climate change amplified in the high Arctic has a profound effect on circum-Arctic populations. This is particularly emphasised by social and economic damage arising from more frequent climate induced extreme events. Anthropogenic feedbacks into the Cryosphere-Atmosphere-Ocean system need to be investigated and evaluated with much greater precision. A dedicated European scientific research platform will significantly contribute towards observation and monitoring of changes in the environment at high latitudes. Polar marine research over the next 10-15 years will concentrate on the long-term natural variability within the ecosystems of the Arctic Ocean. This will focus on the feedbacks between atmosphere, sea-ice, ocean and biological systems. In particular the propagation of anomalies through the system is used to understand the pelagic ecosystems during the different seasons, the response of planktonic systems and benthic biota to variations in sedimentation and river supply as well the distribution pattern of anthropogenic contaminants in the Arctic.

Climate models demonstrate the sensitivity of the Arctic basin to changes in forcing of the Ocean Climate system. Snow and Ice cover influence global heat distribution and the polar ocean are the source of dense, cold bottom waters, which influence thermohaline circulation in the world's oceans. The global conveyor is a major determinant of climate. In spite of the critical role of the Arctic Ocean for climate evolution in the Northern Hemisphere, it is the only sub-basin of the world's oceans that have not been sampled by any scientific drill ship and its long-term paleoenvironmental history and tectonic structure is poorly known. This lack of data represents one of the largest gaps of

information in Modern Earth Science. Drilling and sampling of the Arctic basin will be one of the major scientific and technological challenges of this decade and one in which Europe will play a key role in realising this goal. It would be a European contribution to IODP (Integrated Ocean Drilling Program) and the AURORA BOREALIS could be considered one of the European alternate platforms.

The main strength of the AURORA BOREALIS project is that it is a unique research platform providing the solution to several multidisciplinary scientific demands. The concept provides a pathway to the development of a European Research area in Arctic System Science and is at the heart of European cooperation in polar scientific research and operational capabilities. The implementation of a European Arctic Observing System with AURORA BOREALIS as its core will open up long-term perspectives to international programmes and enable adequate knowledge and sound policy advice to governments on the status of changes to the global environment.

This Science plan will provide a basis for future scientific investigations of the High Arctic and define a 'decadal' strategy for European cooperation in Arctic Science.

The present science plan has mainly an Arctic perspective because sufficient research capabilities will be available in the Antarctic waters for the coming decade. However, considering the bipolar research interest of many of the European and polar research programmes, it is clear that the AURORA BOREALIS project has also in the Antarctic perspective providing the ability to conduct all-season research as well as deep-sea drilling activities in the ice-infested waters of the Southern Ocean. The Annual transit of research icebreakers between Arctic and Antarctic waters is not an efficient mechanism. However, once a decade of dedicated research has been carried out in the Arctic Ocean, it is probably time to assess the scientific progress and to move in the meantime the AURORA BOREALIS for an extended period to the Southern Ocean to provide an efficient and modern research platform also for those waters.

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**March 2003**

**Jörn Thiede Chairman of the AURORA BOREALIS International Science Planning Committee and of the European Polar Board of ESF with 20 member nations**